What is claimed is:

1. A DC-DC converter including a power transformer having first and second windings inductively coupled and connected with first and second circuits, respectively, a first semiconductor switch in the first circuit connected in current conducting relation to the first winding of the power transformer and a second semiconductor switch in the second circuit connected in current conducting relation to the second winding of the power transformer; the improvement comprising:

a first control circuit coupled to the first circuit in controlling relation to the first semiconductor switch, a second control circuit coupled to the second circuit in controlling relation to the second semiconductor switch, at least one of the first and second control circuits having a current sensor for detecting the direction of current through the semiconductor switch controlled by that control circuit and enabling the turning ON of that semiconductor switch when a reverse current through the semiconductor switch is detected.

2. The DC-DC converter according to claim A1, wherein both of the first and second control circuits have a current sensor for detecting the direction of current through each semiconductor switch controlled thereby and enabling turning ON of that semiconductor switch.

3. The DC-DC converter according to claim 1, wherein each of the control circuits having a current sensor for detecting the direction of current is adapted to apply to a control electrode of the semiconductor switch controlled by that control circuit a signal turning ON that switch at a time subsequent to detection of a reverse current through that switch, while current in that switch is still reverse current and when voltage across that switch has reached substantially zero volts.

4. The DC-DC converter according to claim 2, wherein each of the control circuits having a current sensor for detecting the direction of current is adapted to apply to a control electrode of the semiconductor switch controlled by that control circuit a signal turning ON that switch at a time subsequent to detection of a reverse current

through that switch, while current in that switch is still reverse current and when voltage across that switch has reached substantially zero volts.

5. The DC-DC converter according to claim 2, wherein at least one of the control circuits is adapted to turn OFF the semiconductor switch controlled by that control circuit responsive to at least one of input voltage to the DC-DC converter, output voltage of the DC-DC converter, voltage across one of the first and second windings, and current in one of the semiconductor switches.

6. The DC-DC converter according to claim 5, wherein the at least one control circuit adapted to turn OFF the semiconductor switch is the first control circuit.

7. The DC-DC converter according to claim 5, wherein the at least one control circuit adapted to turn OFF the semiconductor switch is the second control circuit.

8. The DC-DC converter according to claim 5, wherein the at least one control circuit adapted to turn OFF the semiconductor switch comprises both the first and second control circuits.

9. The DC-DC converter according to claim 1, wherein at least one of the first and second control circuits includes a control winding wound on the power transformer.

10. The DC-DC converter according to claim 1, wherein the converter is reversible, either of the first and second circuits with which the first and second windings are connected is adapted to serve as either a primary, input circuit or a secondary, output circuit of the converter.

11. A self-regulating DC-DC converter including a power transformer having a primary and a secondary winding inductively coupled and connected with a primary and secondary circuit, respectively, a primary semiconductor switch in the primary circuit connected in current conducting relation to the primary winding of the power transformer and a secondary semiconductor switch in the secondary circuit

connected in current conducting relation to the secondary winding of the power transformer; the improvement comprising:

(a) first control means for controlling the first semiconductor switch,

(b) second control means for controlling the second semiconductor switch,

(c) means for sensing current in one of the first and second semiconductor switches, and

(d) one of the control means being connected with the means for sensing and adapted to turn ON the semiconductor switch at substantially zero voltage across the switch and reverse current through the switch as sensed by the means for sensing.

12. The DC-DC converter according to claim 11, further comprising:

(e) further means for sensing current in the other of the first and second semiconductor switches, and

(f) the other of the control means being connected with the means for sensing current in the other of the first and second semiconductor switches and adapted to turn ON that other semiconductor switch at substantially zero voltage across that switch and reverse current through that switch as sensed by the further means for sensing.

13. A self-regulating DC-DC converter including a power transformer having a primary and a secondary winding inductively coupled and connected with a primary and secondary circuit, respectively, a primary semiconductor switch in the primary circuit connected in current conducting relation to the primary winding of the power transformer and a secondary semiconductor switch in the secondary circuit connected in current conducting relation to the secondary winding of the power transformer; the improvement comprising:

(a) a secondary circuit voltage sensing control circuit operatively connected with the second semiconductor switch in controlling relation thereto, and connected to sense a voltage in the secondary circuit related to the converter output voltage,

(b) the secondary winding being coupled to conduct a diminishing current in a forward direction upon the termination of current in the primary winding by the primary switch, and

(c) the secondary circuit voltage sensing control circuit being responsive to the voltage sensed to turn OFF the secondary switch when current in the secondary winding is in a range from substantially zero current and a reverse current level to induce in the primary winding a current level in a range from zero current to a reverse current level to thereby cause, when the secondary circuit voltage sensing control circuit senses an over-voltage condition, energy to be transferred back to the primary winding circuit from the secondary winding circuit at a level depending on the level of over-voltage.

14. The DC-DC converter of claim 13, wherein the secondary circuit voltage sensing control circuit comprises a comparitor having a reference voltage source connected to one input thereof, the voltage related to the converter output voltage connected to another input thereof and a control electrode of the secondary semiconductor switch coupled in switch controlling relation to an output of the comparitor.

15. The DC-DC converter of claim 13, wherein the secondary circuit voltage sensing control circuit is connected to sense the voltage across the secondary winding as the voltage in the secondary circuit related to the converter output voltage.

16. The DC-DC converter of claim 14, wherein the secondary circuit voltage sensing control circuit is connected to sense the voltage across the secondary winding as the voltage in the secondary circuit related to the converter output circuit.

17. The DC-DC converter of claim 16, wherein the secondary circuit voltage sensing control circuit includes a voltage divider connected across the secondary winding and supplying as the another input to the comparitor the voltage related to the converter output voltage.

18. The DC-DC converter of claim 17, wherein the secondary semiconductor switch is a MOSFET having its gate connected with the output of the comparitor.

19. The DC-DC converter of claim 13, wherein each of the primary and secondary semiconductor switches has substantially zero voltage turn ON, the transfer of energy back to the primary upon detection of an over-voltage in the secondary winding decreasing the duty cycle of the converter by altering the switching times of the secondary semiconductor switch.

20. The DC-DC converter of claim 19, further comprising a primary semiconductor switch control circuit coupled in controlling relation to a control electrode of the primary semiconductor switch to turn ON and turn OFF that switch.

21. A DC-DC converter including a power transformer having first and second

windings inductively coupled and connected with first and second circuits, respectively, a first semiconductor switch in the first circuit connected in current conducting relation to the first winding of the power transformer and a second semiconductor switch in the second circuit connected in current conducting relation to the second winding of the power transformer; the improvement comprising:

a first control circuit coupled to the first circuit in controlling relation to the first semiconductor switch, a second control circuit coupled to the second circuit in controlling relation to the second semiconductor switch, each of the first and second control circuits having a sensing element for detecting one or more operating parameters of the first and second circuits and enabling the turning ON of that semiconductor switch in response to one or more operating parameters.

22. The DC-DC converter of claim 21, wherein at least one of the sensing elements is a control winding on the power transformer coupled with one of the first and second first and second windings.

23. The DC-DC converter of claim 21, wherein the sensing elements are responsive to one or more of the operating parameters selected from the group consisting of direction of current in one of the semiconductor switches, level of current in one of the semiconductor switches, voltage across the first winding, voltage across the second winding, input voltage to the converter, output voltage from the converter and a time delay.

24. The DC-DC converter of claim 22, wherein the control winding is in the second circuit and is coupled to the second winding, said second winding being a secondary winding.

25. The DC-DC converter of claim 24, wherein the second semiconductor switch is a MOSFET in the second circuit and coupled in current controlling relation to the secondary winding, the MOSFET having an intrinsic turn-ON threshold, the

intrinsic turn-ON threshold and the number of turns in the control winding controlling the turn-ON of the second semiconductor switch and the output voltage of the converter.

26. The DC-DC converter of claim 21, wherein the converter is a reversible converter, each of said first and second circuits responsive to an input to serve as a primary circuit supplying its associated one of the first and second windings on the power transformer and developing an output in the other of said first and second circuits serving as a secondary circuit.

27. The DC-DC converter of claim 26, wherein each of the sensing elements in the first and second circuits is a current sensing element connected to sense current in the first and second semiconductor switches, respectively.

28. The DC-DC converter of claim 27, wherein each of the first and second control circuits is responsive to a reverse current through the respective semiconductor switch sensed by the first and second current sensing elements, respectively, to turn ON the associated one of the first and second semiconductor switches at substantially zero voltage across that switch.

29. The DC-DC converter of claim 28, wherein each semiconductor switch is a MOSFET and each MOSFET is turned ON at substantially zero drain voltage and reverse current through the switch.

30. The DC-DC converter of claim 28, wherein the turn OFF times of the first and second semiconductor switches determines the direction of power flow through the converter.

31. The DC-DC converter of claim 30, wherein turn OFF of each semiconductor switch is based on one or more circuit parameters of the one of the first and second switches connected with that switch.

32. The DC-DC converter of claim 31, wherein the one or more parameters are chosen from the group consisting of converter input voltage, converter output voltage, first winding voltage, second winding voltage, and current level in the switch.

33. In a DC-DC converter having a primary circuit connected to a primary winding of a transformer and a secondary circuit connected to a secondary winding of a transformer, an input connection to the primary circuit adapted to receive an input voltage and a load connection to the secondary circuit adapted to connect an output voltage to a load, a first signal-controlled semiconductor switching device in the primary circuit connected in current-controlling relation to the primary winding of the transformer, and a positive feedback path including a further winding of the transformer in the primary circuit, the feedback path connected to apply a control signal in controlling relationship to the first signal-controlled semiconductor switching device; the improvement comprising:

(a) a second signal-controlled semiconductor switching device in the secondary circuit connected in current switching relationship to the secondary winding of the transformer,

(b) a control circuit connected in controlling relation to the second signal-controlled semiconductor switching device in the secondary circuit, the control circuit being connected to produce a control signal dependent on a relationship between the output voltage of the converter and a reference voltage,

(c) a reference voltage source providing the reference voltage, and

(d) the control circuit having an output voltage-dependent, voltage-supplying circuit connection to the load connection and a connection to the reference voltage source, whereby the control circuit effects energy transfer back to the primary circuit when output voltage rises so as to alter the duty cycle of the first signal-controlled semiconductor switching device to thereby regulate output voltage.

34. A method of DC-DC conversion comprising:

(a) providing a power transformer,

(b) providing first and second semiconductor switches in current conducting relation with first and second windings, respectively, on the power transformer,

(c) applying an input DC voltage to a first circuit coupled to the first pair of windings,

(d) turning OFF the first semiconductor switch to induce a reverse current in the second winding and through the semiconductor switch in current conducting relation therewith,

(e) turning ON the second semiconductor switch connected with the second winding when voltage across the second winding is substantially zero and while current in the second winding and second semiconductor switch is reverse current,

(f) turning OFF the second semiconductor switch when current in the second winding and second semiconductor switch is forward current, and

(g) turning ON the first semiconductor switch connected with the first winding when voltage across the first winding is substantially zero and while current in the first winding and the first semiconductor switch is reverse current.

35. The method of DC-DC conversion of claim 34, further comprising:

(h) providing a first control circuit and a second control circuit coupled in controlling relation to a control terminal on the first and second semiconductor switches, respectively,

(i) coupling first and second current sensors in current sensing relation with the first and second semiconductor switches, respectively, and

(j) inputting first and second current direction signals to the first and second control circuits from the first and second current sensors, respectively.

36. In a method of DC-DC conversion wherein an input voltage is applied via a first circuit to a first winding of a power transformer, a first semiconductor switch is turned ON to cause current conduction through the first winding and turned OFF to induce current conduction in a second winding, a second semiconductor switch is connected in a second circuit supplying an output voltage from the second winding to an output of the converter, the improvement comprising:

(a) detecting when their is a reverse current through the second semiconductor switch,

(b) turning ON the second semiconductor switch while current therethrough is in a range from zero current to a level of reverse current and when voltage across the second semiconductor switch is substantially zero, and

(c) turning OFF the second semiconductor switch after a period of forward current conduction therethrough and through the second winding.

37. The method of DC-DC converting according to claim 36, further comprising:

(d) sensing at least one operating parameter of the second circuit and turning OFF the second semiconductor switch in response thereto.

38. The method of DC-DC converting according to claim 37, wherein the operating parameter is chosen from the group consisting of voltage across the second winding, current in the second semiconductor switch, and a set time delay.

39. The method of DC-DC converting according to claim 37, further comprising:

(e) sensing at least one operating parameter of the second circuit and when the second semiconductor switch is conducting the current that is in the range from zero current to a level of reverse current switching ON the second semiconductor switch in response to the operating parameter sensed.

40. The method of DC-DC converting according to claim 39, wherein the operating parameter is chosen from the group consisting of voltage across the second winding, current in the second semiconductor switch and a set time delay.

41. The method of DC-DC converting according to claim 37, wherein the at least one operating parameter is voltage across the second winding and the step of sensing the at least one operating parameter comprises providing a reference voltage, comparing the voltage across the second winding to the reference voltage and applying a forward biasing central signal to a control terminal of the second semiconductor switch when the voltage across the second winding has a predetermined relationship to the reference voltage.

42. The method of DC-DC converting according to claim 37, further comprising:

(f) detecting when there is a reverse current through the first semiconductor switch,

(g) turning ON the second semiconductor switch while current therethrough is in a range from zero current to a level of reverse current, and when voltage across the first semiconductor switch is substantially zero.

43. In a method of DC-DC conversion wherein an input voltage is applied via a first circuit to a first winding of a power transformer, a first semiconductor switch is turned ON to cause current conduction through the first winding and turned OFF to induce current conduction in a second winding, a second semiconductor switch is connected in a second circuit supplying an output voltage from the second winding to an output of the converter, the improvement comprising:

(a) sensing in the second circuit a first voltage related to an output voltage of the converter,

(b) comparing the first voltage to the reference voltage, and

(c) turning ON the second semiconductor switch when the first voltage bears a predetermined relationship to the reference voltage.